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ABSTRACT

This interim report reviews the major incentive policy options available to accelerate market penetration of solar heating and cooling (SHAC) systems. Feasible policy options designed to overcome existing barriers to commercial acceptance and market penetration are identified and evaluated. The report is divided into seven sections, each dealing with a key problem relating to the widespread use of SHAC systems: (1) economic and financial incentives; (2) solar energy/public utility interface; (3) legal and regulatory issues; (4) Energy Research and Development Administration (ERDA) patent policy; (5) building codes, standards, and warranties; (6) marketing, manpower, consumer, and environmental issues; and (7) regional aspects of the incentives program. Within each of these areas the important potential barriers to the commercialization of SHAC systems are identified, assessed, and evaluated. The most effective incentive options are evaluated and in a detailed, comprehensive appendix, each of these incentive options is analyzed in depth, and numerous other potential incentives are also discussed. Listings of state solar energy legislation enacted or proposed as of January 1977 are given in the appendix. (Author/MLF)

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Division of Solar Energy
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It was written with the assistance of:

Joseph B. Margolin, Ph.D., Director
The George Washington University Behavioral Studies Group

George Sponsler, Ph.D., President
International Planning Management Corporation

Thomas Sparrow, Ph.D., Chairman
University of Houston, Department of Industrial Engineering

Frank Meeker, Esq., and Alan Miller, Esq.
Environmental Law Institute

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Total Environmental Action, Subcontractor Bruce Anderson, M.A.(Architecture),Project Manager	"Solar Energy Public Utility Interface: An Assessment of Policy Options"
University of Houston, Department of Industrial Engineering Thomas Sparrow, Ph.D., Principal Investigator	"Incentives for and Barriers to Solar Energy: A Design for A Demonstration and Research Workshop"

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I. OVERVIEW

This interim report reviews the major incentive policy options available to accelerate market penetration of solar heating and cooling (SHAC) systems. The policies described provide alternative methods for enhancing the impact of the Solar Heating and Cooling Demonstration Program. The report is based on research and data available as of February 1977 and will be updated periodically as the results of ongoing research become available. Specific policies or a set of policies are not recommended. Feasible policy options designed to overcome existing barriers to commercial acceptance and market penetration are identified and evaluated. No attempt has been made to estimate precisely the costs or impacts which would result from the policy options discussed.

The cost effectiveness of SHAC systems is a function of the solar systems costs and the prices of alternative energy sources. Other energy sources have received a wide range of subsidies throughout the production and distribution systems, and the prices charged for these sources of energy are by no means laissez-faire free market prices. This fact does not justify incentives or special consideration for solar energy. However, it does lend perspective to the problem and indicates that there are precedents in the U.S. for using economic and institutional incentives to stimulate the development of energy resources.

This report is divided into the following seven sections, each dealing with a key problem area relating to the widespread use of SHAC systems:

Economic and Financial Incentives

The Solar Energy/Public Utility Interface

Legal and Regulatory Issues

ERDA Patent Policy

Building Codes, Standards and Warranties

Marketing, Manpower, Consumer and Environmental Issues

Regional Aspects of the Incentives Program

Within each of these areas the important potential barriers to the commercialization of SHAC systems were identified, assessed, and evaluated. The results of previous barriers and incentives studies were carefully reviewed. Contract studies of the policy options available were commissioned, and a five-day workshop on the problem was held in the fall of 1976, where the evaluations of researchers and experts in the field were obtained. From these sources it was possible to isolate the most serious constraints to the widespread use of SHAC systems and to determine the types of incentives likely to best deal with these constraints. In this report the most effective incentive options are evaluated. In a detailed, comprehensive appendix to this paper, each of these incentive options is analyzed in depth, and numerous other potential incentives are also discussed. Listings of state solar energy legislation enacted or proposed as of January 1977 are given in the appendix.

This project does not consider every possible policy option or variation. However, the range of options discussed in this report and its appendix does include virtually every major incentive likely to be considered. For example, the complete set of economic incentives is illustrated in Table I-1. The rows of this table list the generic types of economic incentives and the columns indicate where in this report or the appendix an analysis of a particular incentive can be found.

TABLE I-1

LISTING OF ECONOMIC INCENTIVES

Type of Incentive	Where Considered								
	Ch. II	Ch. III	Ch. IV	Ch. V	Ch. VI	Ch. VII	Ch. VIII	Appendix	State Legislation
1. Direct grants	X							X	
2. Income tax credits	X							X	X
3. Income tax deductions	X							X	X
4. State and local property and sales tax incentives	X		X					X	X
5. Low-cost loans	X							X	X
6. Guaranteed loans	X							X	
7. Accelerated depreciation/rapid amortization								X	X
8. Government insurance and reinsurance					X			X	
9. Government procurement	X							X	X
10. Demonstration programs	X							X	
11. Government equity investment								X	
12. Tax-free bonds								X	
13. Government incentives for utilities		X						X	X
14. Tax on fuel or deregulation	X							X	
15. Information dissemination						X	X	X	X
16. Protective tariff								X	
17. Deregulation of prices of fossil fuels	X							X	
18. Education and training programs						X	X	X	
19. Research and Development programs	X	X	X		X	X		X	X

II. Economic and Financial Incentives

POLICY OPTIONS

1. The federal government could make available loan guarantees to lenders to insure loans for the purchase of SHAC equipment, and federally sponsored loan guarantees for the purchase of capital equipment to be used in the production of SHAC equipment can be offered to small or under-capitalized businesses.

2. The federal government could grant income tax credits for the purchase of SHAC equipment and extend the investment tax credit to include purchases of SHAC equipment by businesses.

3. The present solar energy heating and cooling demonstration program could be supplemented by a major federal government procurement program designed to install SHAC equipment on selected federal buildings, where justified on the basis of life cycle costing.

4. A federal tax credit could be enacted to reimburse purchasers of solar equipment for sales and for property taxes imposed at the state and local level.

5. A program of low interest loans could be offered by the federal government to the purchasers of SHAC systems and to the manufacturers of solar equipment for the purchase of capital goods.

6. Direct subsidies could be provided by the federal government to the producers or purchasers of SHAC equipment.

7. Deregulation of the prices of fossil fuels could provide a powerful incentive for solar energy and energy conservation; a tax on fossil or polluting fuels would have similar effects.

DISCUSSION

1. Loan Guarantees

Federal guarantees of loans for the purchase of solar heating and cooling systems for new and existing buildings and for the purchase of capital equipment by solar equipment manufacturers can be considered as an incentive. Basically, it places the credit of the government behind the borrower. This can be especially important to consumers in lower income brackets, or who are poor credit risks, who would have to pay a risk premium to borrow money. It would also benefit a fledgling industry. In both cases the direct costs to the taxpayer would be relatively low. There are many sound precedents (e.g. FHA, VA) and both the method and necessary data base are largely available. Government guarantees would ease the concern of banks, utilities, and lending institutions, and reduce uncertainty concerning solar equipped buildings and solar manufacturers. On the assumption that the loan default level would be relatively low--which is likely to be the case if the guarantee includes a second mortgage on the property--the loan guarantee incentive would have high leverage producing maximum benefits at a low direct cost.

While some large corporations are interested in the production of solar equipment, a considerable number of small, poorly capitalized firms are entering, or would like to enter, the market. Their entry into the field would probably improve the level of creativity, innovation and competition, and thereby enhance the state of the art and decrease prices. An SBA or similar program of low interest loans and guarantees could be extended to these organizations if there is evidence that such support is required.

The loan guarantee program would produce little distortion in the economy and would complement private efforts. Its administrative efficiency would be high, since the machinery for loan guarantees already exists in the housing industry and in several industrial sectors. The resulting availability

of capital for investment would prove an incentive for both industry, financial institutions, and consumers. In addition, by demonstrating to those affected by rising fuel prices that the government is concerned about the problem, the loan guarantee program could have social benefits of a more intangible nature.

A loan guarantee program could also have its drawbacks. While, theoretically, loan guarantees are attractive to individuals in the lower income brackets, these individuals might not apply for the guarantees. Individuals in the lower income brackets do not usually own their prime residence. If they do, they may not be in a position to invest in SHAC systems--even with incentive support, or to finance the energy conservation measures necessary to make solar space conditioning effective. Such a program could conceivably suffer from the types of problems that have plagued student loan programs (i.e., a high default rate). Further, the likely rate of default is uncertain, since the debt servicing ability of the borrower will determine the default rate. Finally, in a capital constrained economy, credit allocation programs could have impacts which rival those of direct appropriation programs.

2. Tax Incentives

A federal income tax credit for the purchase of solar heating and cooling systems has already been incorporated in a variety of congressional bills. An income tax credit could take the form of a fixed percentage of the purchase price, up to a maximum amount. The impact of a tax credit would be felt in the year in which the SHAC investment is made, thus directly reducing the high "first-cost barrier" to the installation of SHAC equipment. Income tax credits,

as distinct form deductions, extend the same savings to taxpayers in different brackets. Income tax credits for SHAC systems may have a stimulating impact on the economy, if they substitute for less efficient investments. Unlike unrestricted tax credits, the credit would be for money actually spent on an investment that will lower utility costs and conserve energy.

Tax credits to promote the purchase of solar equipment by building owners would parallel the extension of the investment tax credit for purchase of solar equipment by businesses. Under existing federal tax law, solar energy systems generally do not qualify for the investment tax credit allowable on certain types of business capital equipment. The Internal Revenue Service has considerable experience in managing this type of investment credit.

Estimates indicate that the cost-effectiveness to the government of tax credits would be higher than that of many other incentives. The necessary administrative mechanism--the IRS-- is already in place. If a general tax relief program is contemplated, then some portion of the tax rebate could be constructively directed to serve as an incentive to encourage the adoption of solar energy. The income tax credit could increase the market penetration of solar energy systems, by calling the attention of consumers to the potential of SHAC systems and making their purchase more feasible by directly reducing first costs.

One major shortcoming of a tax credit is in the delay with which the payment is received. This could be overcome, in part, by early payment of the credit. The cost to the government in terms of lost revenue would be direct and relatively large. Another potentially serious problem is that changes in the tax code, once enacted, are difficult to remove and often outlive their usefulness. If a tax incentive program is proposed, it is important that it be strictly time-limited with a specific termination date.

3. Government Procurement Program

The fitting and retrofitting of government-owned buildings with SHAC systems offers an incentive that can be effectively planned and controlled. A limited government procurement program is currently being conducted as part of the Solar Heating and Cooling Demonstration Program. An expanded government procurement program could stimulate the development of new technology, encourage investment by solar equipment manufacturers, generate information useful to the insurance industry and financial institutions, and, in conjunction with an associated public information program, encourage consumer acceptance and recognition of the value of solar energy. The program may also reveal any unanticipated labor union jurisdictional problems as well as help identify difficulties with building codes, standards and warranties. Installation of the solar equipment in thermally efficient buildings could result in reduced operating costs for the federal buildings themselves, especially if life cycle costing criteria are rigorously applied. The diversity of federal government installation sites would provide a challenge to solar manufacturers and suppliers and increase creativity and innovation. No particular segment of the population would benefit or be impacted more severely than another.

The administrative efficiency of this incentive is attractive, for much of the procurement and quality control machinery is already in place in the GSA and other government agencies. Whereas the cost of a government procurement program could be initially high, rapidly escalating fuel prices could increase the return on such an investment. Market penetration could follow upon the development of the solar industry and the demonstration of confidence provided by the federal government. To be successful it is essential that the

federal buildings program to be at a high enough level over a sustained period of time to lure investment into production, tooling, distribution systems, etc. This type of program should have the objective of guaranteeing a minimum size market for a period of time sufficient to realize some economies of scale in production and installation.

In addition, an expanded government procurement program would offer stimulus to the construction industry at large, as well as to the new SHAC industry and would create jobs in the construction and HVAC industries. It would also provide a strong indication that alternative sources of energy were possible and that the U.S. government was committed to utilizing them. On the other hand, government procurements are often characterized by relatively high costs and cost overruns. If a federal SHAC procurement program was initiated, care would have to be taken to ensure that an artificially high cost industry is not created. Further, the scope of the government investment necessary to realize the required economies of scale would be extremely large.

4. Federal Reimbursement for State and Local Property and Sales Taxes

To encourage state and local governments to exempt SHAC systems from sales taxes and incremental property tax assessments, a federal reimbursement program could be established. The combined impact of a sales and incremental property tax waiver for SHAC systems could have significant impact on commercialization prospects for solar energy in certain regions. It would also represent a mechanism for achieving the desired cooperation of the states.

On the other hand, such a policy could also lead to certain abuses. For example, property tax assessors, realizing that the federal government would pay for the incremental tax resulting from assessment of a solar building, may be inclined to assess the solar installation at an excessive rate. Further, such a tax policy may be difficult to terminate. A different method of

achieving the same result would be the denial of certain forms of federal aid to states that have not enacted the desired property and/or sales tax waiver for SHAC equipment.

5. Low Interest Loans and Interest Subsidies

A primary barrier to investment in SHAC systems is their high initial cost. Low interest loans represent a promising method for overcoming this barrier by providing capital when it is needed at reasonable rates. A program of low interest loans could be offered by the government for original installation and/or retrofit. Low interest loans would provide the greatest benefit to those in the low and middle income groups(to the degree they invest in SHAC systems)who usually pay the highest interest rates and who benefit the least from conventional interest deductions.

Conditions of rapidly rising fuel costs would enhance the value of the low interest loan incentive. The solar user is in a position to make a capital investment at a low rate of interest to reduce future purchases of fuel--which is likely to be characterized by a high rate of price increase. Low cost residential loans can be administered through the existing federal/private channels for providing housing loans. Government borrowing for this purpose would not, by itself, be of a magnitude sufficient to seriously distort the capital market. However, the cost to the government could be high over the lifetime of the loans. Further, such a program would have to be evaluated in the context of a growing proliferation of loan guarantee and low interest loan programs which, taken as a whole, could distort capital markets.

The federal government could also make low cost funds available through interest subsidies. There are at least two methods of subsidizing loans made through private lenders, with the federal government paying the differential between the established or "going" interest rate and the incentive loan rate.

One method involves a direct payment of the interest differential to the lender, using federal funds for the payments. Another method would be similar to that employed by the Federal Home Loan Bank and involves purchase by the federal government of the loan from the financial institution and resale of it to the public in the form of guaranteed certificates. In this case the federal government would be providing only the interest on the debt, not the capital.

6. Direct Subsidies

The federal government could offer grants and subsidies to consumers and manufacturers to cover part of the purchase cost of buildings equipped with SHAC systems or for capital equipment required by solar manufacturers. The promptness with which a subsidy can be delivered may be a significant measure of its power because of the "first cost barrier." Direct grants or subsidies also differ from tax credit incentives in that they require no changes in the tax code that may be difficult to rescind. The grant could be treated as any other component of gross income for tax purposes, as has been advocated by the Treasury Department. On the other hand, the administrative costs of such a program could be high.

7. Deregulation of Fossil Fuel Prices and/or Increased Tax on Fossil Fuels

Deregulation of the price of fossil fuels competing with solar energy and the related policy of taxation of such competitive fuels represent policies designed to equate the marginal private costs and marginal social costs of energy. Since the competitiveness of SHAC systems varies in direct proportion to the costs of alternative sources of energy, raising the prices of the latter would encourage the adoption and more extensive use of solar energy. These two policies would be very effective stimuli to solar energy development, but that advantage may be gained at great cost to the nation's low and medium income groups and to the economy as a whole.

The effect of the deregulation policy would be to increase the price of alternative fuels, encourage energy conservation, and in the long run, to increase the supply of these sources of energy. Such a policy would be clearly regressive. Deregulation and a tax on alternative fuels probably represent the lowest direct cost alternatives to the government for rapidly and substantially enhancing the competitive position of SHAC systems. Indeed, in the case of a tax on fuel the net cost to the government would be negative, since the tax would result in net revenues to the government. Both policies would accelerate market penetration of SHAC systems and facilitate innovation in the solar energy industry. Both policies would be inflationary in the short run and could have serious income redistribution effects in the long run. They would have the least inflationary impact when the economy is operating significantly below full capacity. Although deregulation would be welcomed by the energy industry, the tax on fuel would be unpalatable to energy producers and energy consumers alike, and the latter alternative may be especially difficult to implement.

However, the great advantage of deregulation, which is often overlooked, is that it would allow solar energy to compete in something approximating a free market. This fact cannot be emphasized strongly enough. The other financial incentives discussed in this chapter would tend, to a greater or lesser degree, to introduce additional distortions into the economy. Further, the economic and the income distribution effects of price deregulation could be alleviated by the enactment of policies to mitigate the impact on the nation's low and medium income groups. For example, a policy of gradual price decontrol could be accompanied by a program of fuel stamps or other guarantees of fuel access to satisfy a minimum level of basic energy requirements.

RESEARCH RECOMMENDATIONS

1. Continued strong emphasis in the solar heating and cooling R & D program is required to achieve reductions in production and installation costs of solar equipment, especially for small scale residential solar cooling systems.

2. Cost-benefit studies should be expanded in the following areas:

   a. Utility incentives, especially federally insured bonds exempt from state taxation.
   b. Government equity investment in solar equipment and manufacturing companies.
   c. Government insurance and reinsurance against the risk of solar equipment failure.

3. Analytical modeling is required to better quantify the probable market penetration resulting from the impact of individual or combinations of economic and financial incentives.

4. Concurrent with the adoption of an incentives package, an evaluation effort designed to measure the effectiveness of the incentives package against its legislative goals should be initiated. The effort should be designed: (a) to provide information as early in the life of the incentives program as is possible, to permit any necessary mid-course corrective action; (b) to aid in the design of other incentive plans the government might undertake.

III. THE SOLAR ENERGY/PUBLIC UTILITY INTERFACE

POLICY OPTIONS

1. Uniform national policies relating to the solar energy/public utility interface are not advisable; local policies must be devised on a region by region basis. The federal government can discourage the states and the PUC's from implementing policies known to be detrimental to SHAC systems, such as the Colorado "energy demand" rate structure.

2. ERDA can give increased emphasis to utility and public utility commission participation in future solar demonstration projects.

3. Utilities should be encouraged to experiment with different rate structures, including peak/off peak, interruptible and time of day rates, to determine their impact on the competitiveness of SHAC systems.

4. The federal government can investigate the interface of SHAC systems with the different types of utilities: gas utilities, electric utilities, combined utilities, and utilities that distribute electricity generated by other utilities.

5. The federal government should encourage the states and the PUC's to experiment with both regulated competitive utility ownership and unregulated competitive utility ownership of SHAC systems. Neither utility monopoly of the SHAC market nor complete exclusion of utilities from the SHAC market is advisable.

6. The impact of both passive and active solar heating and cooling systems on electric utility load factors and economics must be explored.

7. Incentives other than direct financial incentives to obtain utility involvement in the SHAC market could be developed.

DISCUSSION

1. Uniform National Utility Policies

Because of the variation of public utility commission policies from state to state and other regional differences, uniform national utility policies relating to solar energy are not advisable. Fuel costs in

particular vary greatly from region to region. Policies designed to equate the marginal social costs of energy to energy prices are desirable and would tend to make SHAC systems more competitive, but any such policy would have to reflect specific local conditions. Thus, to the extent that time-of-day pricing equates marginal social cost to price, it is a desirable policy to pursue, but it would have to be handled on a regional basis. Similarly, interruptible service is also a policy worth considering, but again only on a region by region basis because of differences in load factors. Each utility policy must be considered on its own merits for the particular region and PUC involved.

Until regional utility interface policies can be devised, policies and rate structures known to be detrimental to SHAC systems should be avoided. A prime example of the type of policy to avoid is the Hopkinson rate schedule recently adopted in Colorado, which discriminates against the owners of SHAC systems with electric backup systems. The federal government can provide information to state energy agencies and PUC's concerning the likely impact on the economics of SHAC systems of certain types of utility policies and rate schedules.

2. Utility and PUC Participation in Solar Demonstration Projects

Two of the most formidable barriers to the market penetration of SHAC systems (particularly the retrofit market) are the high initial cost of the solar heating and cooling systems, and the disaggregated nature of the market. Even the largest builder does not represent

a large enough market to bring down the costs significantly through economies of scale. These barriers could be overcome by finding large, technically sophisticated customers, who can borrow money at the lowest prevailing rates, and who are both protected against loss and prevented from making excessive profits. Utility companies, particularly natural gas companies supplying individual homes, appear to fit this description, and a coherent strategy could consist of developing their potential for aggregating the solar space and water heating market.

Solar heating offers particular advantages, since the natural gas it saves can be easily stored by gas companies and diverted to other uses, such as supplying their interruptible customers. Solar cooling, on the other hand, presents a different market aggregation problem, which needs to be addressed in a different manner, since the interface is primarily with the electric utilities. This illustrates the necessity of considering individually the SHAC interface between the different types of utilities, particularly on a regional basis.

Primary regulatory jurisdiction over solar heating and cooling of buildings will be at the state level, since neither the Federal Power Commission nor any other federal agency has jurisdiction over retail intrastate energy sales. A number of state regulatory commissions already do have statutory jurisdiction over the production or sale of "heat and cold." The major reason for the existence of public utility

commissions is to regulate the control of utility rates in their region of jurisdiction. The PUC's are empowered to set rates for utilities which are "just and reasonable" and no public utility may charge rates disapproved by the PUC. Under existing regulations and precedents, utilities would necessarily be assured a reasonable return on their investment in solar heating and cooling ventures. However, the financial difficulties projected for various solar systems make the utilities skeptical as to their ability to receive the guaranteed profit and the rates of profit the PUC's extend to the utilities are generally lower than those typically demanded by private industry. Further, under existing PUC regulations utilities may not be assured a reasonable rate of return on their investment in SHAC systems installed on residences, and these regulations may have to be modified. Considerations such as these emphasize the need for gaining further information as to the role of utilities, and especially the PUCs, with respect to the future SHAC market. Because of the importance of the solar/utility interface and because of the present lack of knowledge concerning that interface, active utility and public utility commission participation should be encouraged in future federal government solar heating and cooling demonstration projects.

Consideration should be given to the benefits of cost sharing in such demonstration projects. As a start, the federal government could identify those utility companies which are receptive to solar heating (particularly those who have limited supplies of natural gas available to them and who have interruptible customers), and public utility

commissions who are willing to explore the merits of this approach. Preliminary engineering and economic study contracts could be let to those organizations (such as A/E companies) who have a built in incentive to market to other utility companies, at a later date, the experience they have gained. Even negative responses by utility companies and public utility commissions, after serious evaluation and discussion of the issues, would be valuable. Unanticipated problems could be identified, and a diffusion of increased readiness for solar energy by utility companies at a later date achieved.

3. Alternative Utility Rate Structures

Using telemetry, utilities could provide solar customers with an interruptible supply service at lower than average cost rates approximating marginal cost rates for off-peak supply, making solar more competitive. New legislation could be implemented to encourage utilities to supply such service and consumers to contract for the service. Precendents exist in the electric utility industry and it is common practice in the gas utility industry. This policy permits the utility to interrupt supply for either short "roll-out" intervals or longer periods lasting several peak hours. It thus has important implications for capacity and energy costs. From the standpoint of the utilities, telemetrically controlled interruptible service is an appealing incentive for it would allow them to be better balance their loads. Though the reaction of the consumer to such an arrangement is unknown, no serious difficulties have presented themselves in the several large scale experiments (Detroit Edison) now underway. The impact of such rate variations on SHAC system design and sizing is also an important unknown.

A related policy would be to prohibit the use of peak electricity as back-up for solar systems, ensuring cheap backup power and reducing adverse capacity and energy effects of SHAC equipment. The switching could again be performed telemetrically. The necessary dispersed, small scale thermal energy storage to make this plan feasible has been in existence in Europe for over a decade as a load management tool and could be adopted in this country.

In essence, all of these policies are variations of time-of-day pricing, which is itself a step toward marginal cost pricing. Utility rates, primarily for electric utilities, vary according to capacity and energy costs by time of day, weekday, weekend, and by season. The presumption is that it is possible to mandate time of day pricing to implement the rate schedule through telemetry, double-dial metering, magnetic tape metering, and other methods. To assure that the solar installations of the future do not adversely impact the peak power demands of the electric utilities, but rather offer a complementary demand during off-peak hours, electric utilities in particular should be encouraged to develop and implement different rate structures such as peak/off-peak, interruptible, time of day, and others of a similar nature.

4. Investigations of the Solar Energy Interface with Different Types of Utilities

There are various types of utility companies: those that sell only electricity; those that sell only natural gas; those that sell both; and those that distribute energy generated by others. Each type presents its own problems and/or opportunities for the solar heating and cooling of buildings.

The market aggregation of solar cooling, for example, will require a somewhat different approach than solar heating. Most of the energy for air conditioning is electric. Reduction of electric energy peak load may be especially welcomed by a utility company if it is approaching its allowable maximum, and if the only other alternative is a new fossil fuel or nuclear power plant in the near future. Utility companies with surplus capacity, however, may not be sufficiently motivated to bring about a further load reduction by installing either solar air conditioning or solar heating in the buidings they serve. Alternatively, those smaller utility companies which do not generate their own electricity may be more receptive to the idea of installing and servicing SHAC systems in buildings, and recoving their investment with profit through the usual monthly billing, particularly since regulated utilities can earn profits only on investments in physical capital and cannot earn profits on the resale of energy.

Utilities that sell only natural gas offer considerable potential for interfacing with SHAC systems. First of all, many gas utility companies are faced with serious difficulties in obtaining enough natural gas to supply even their existing customers. SHAC systems may provide an opportunity for gas utilities to limit the decrease in their share of the market and thus to stay in the "energy" business. Second, the difference between the average price and the marginal price of natural gas is large. The price paid by the gas customer reflects average cost pricing, whereas the marginal cost of "new gas" to the utility is well above that average cost. With "new gas" likely to be substantially more expensive than "old gas," solar energy may indeed appear as an attractive alternative to gas utilities. Third, natural gas, because it can be stored

more efficiently than electricity, may prove to be a more efficient backup system for SHAC systems. Finally, due to the factors mentioned above, the gas utility companies themselves may at present be keenly interested in SHAC systems. A government policy to accelerate the market penetration of solar energy can only be successful if the private sectors of the market maintain the solar initiative without continuing government assistance. Gas utility companies may offer significant potential in this regard.

5. Potential Utility Involvement in the SHAC Market

There are four potential degrees of utility involvement in the SHAC market. First, public utilities could be given exclusive monopoly franchises to provide SHAC systems which would substitute for some or all of the other forms of energy used by their customers. Such an arrangement would be accompanied by conventional public utility regulation of the solar component of the system. Second, utilities could be denied a monopoly on solar energy systems, but permitted to enter the SHAC business as a part of their regulated public utility activities. The utility would offer services as in the first case, except that customers could turn to non-utility firms to acquire SHAC components. The third alternative also involves unmonopolized ownership and control of solar systems by utilities, only in this case utility solar energy activities would be provided by a separate unregulated utility affiliate. SHAC systems would be unregulated, and public utilities would face competition from non-utility solar manufacturers. Finally, utilities could be prohibited from owning on-site solar energy systems or the energy derived from them. All of these alternatives have precedent in the regulated public utility sector.

Each of these four alternative involvements has its potential advantages and disadvantages, as indicated in Table IV-I. At present, it is felt unwise either to give public utilities complete monopoly over SHAC systems

or to prohibit them entirely from participation in the SHAC market. It is suggested that the federal government encourage states and PUC's to experiment with variations of alternatives two and three, regulated and un-regulated utility participation in the SHAC market.

Ownership of SHAC systems by th utility responsible for their installation offers certain advantages. Utilities can often borrow money at relatively low market rates; they can deduct depreciation on these units from their income; and they are allowed to make a profit on their investments. Another advantage to active utility participation in the SHAC market is availability of a reliable maintenance and service organization. However, building owners should not be prevented from buying, installing and serving their own solar units.

Manufacture of SHAC systems by utility companies could present problems. A joint solar/gas utility, for example, would have to work out a method of allocating its costs between solar assisted and gas-only services. If allowed to manufacture solar equipment, it could make an allocation that in the absence of appropriate regulaton would, in fact, attribute too much cost to gas, and thus artificially lowering the cost of solar equipment, driving non-utility competitors out of business. Another potential major problem could be public distrust of widespead utility participation in the SHAC market. On the other hand, competitive purchase of solar equipment by a utility from manufacturers might combine the simultaneous advantages of market aggregation and market competition.

In sum, utilities face unique problems from the widespread introduction of SHAC systems. However, the solutions to their problems should not exclude

those complications which would result from such a strong utility participation on those small individual producers of SHAC systems and the impact on the even smaller local HVAC firms, i.e., horizontal integration.

6. Impact of Solar Heating and Cooling Systems on Electric Utility Load Factors

The acceptance of solar heating and cooling by electric utilities faces special problems. One is the decrease in the load factor, and the other is the impact of a prolonged period of bad weather on the electric back-up system. The electrical load factor for a building with SHAC system and electric resistance back up may be lower than that for a conventional "all electric" building. One possible way to solve this problem is analogous to the technique used by the natural gas utilities. They have interruptible customers and peak demands are met by discontinuing gas service to them. This is not so easily done for electrically heated buildings. However, interruptible service to electric water heaters in homes is a possibility that has been used by electric utilities, and this technology is within the state of the art. The substitution of solar for electrical energy may therefore have to be accompanied by a simultaneous introduction of interruptible service to electric water heaters, by telemetry for example. This approach could be an acceptable alternative to building additional peak load capacity, particularly if the regulatory commissions were to insist that this alternative be thoroughly explored by the utility company before planning a new generating plant. More extensive studies need to be made of the nature of the impact of solar heating and cooling on the electrical load factor, and of methods designed to minimize any adverse impacts.

Any future utility rate structures, based on time-of-day or variances thereof, are implicitly controlled by the possible impact of the SHAC systems on utility load factors. However, the solar system need not be active in order to have such an impact. Passive systems in which buildings are designed to make maximum benefit of solar energy through improved insulation, fenestration and similar factors will also have significant impact upon utility load factors and economies. Therefore, both as a prelude to the active solar systems and also because of the importance of passive systems in themselves, it becomes essential to assess the impact of passive solar systems upon utility load factors and economics.

7. Incentives for Utility Company Adoption of Solar Heating and Cooling of Buildings

A fundamental issue here is the potential drop in utility sales, and therefore revenue, due to widespread use of solar heating and cooling. Some types of utilities appear less concerned about this than others. For example, Southern California Gas voluntarily teamed up with JPL and initiated the SAGE project. Since natural gas supplies are limited, it would seem that the gas utilities in general would be favorably disposed to solar energy. Public utility companies which supply only electrical energy at present appear to be less favorably disposed. They cannot easily store their load factor and revenues could decrease with widespread use of solar heating and cooling. The alternate sources of revenue possible through involvement in the SHAC market need to be seriously explored by the various types of utility companies.

To achieve this, incentives may be required. It would be difficult to justify direct financial incentives, since utilities are protected against

loss and regulated against excessive profits. They will have to acquire knowledge and understanding of the utility/solar energy interface; this will cost time and money which they may be reluctant to invest without a better understanding of future benefits. Incentives will have to be devised to overcome this barrier.

RESEARCH RECOMMENDATIONS

1. Simulation models for market penetration forecasting could be devised, incorporating marginal energy and capacity costs and prices for electric and gas utilities.

2. Solar energy components and architectural design should be optimized by employing solar heating and cooling models, actual performance data based on welfare economic efficiency criteria, and data concerning utility cost implications.

3. Passive solar system components (including fenestration, thermal capacitants, conventional auxiliary power, etc.) can be studied in comparison with active solar system design.

4. A study should be made of the efficacy of various regulatory instruments in influencing utility ownership and control of solar heating and cooling systems.

5. Research is required into the technical aspects of automated telemetric control of solar systems and thermal storage, which can optimize utility load factors and encourage the adoption of solar systems, particularly by the electric utilities.

6. A study is recommended of the impact of state, local and federal codes and legislation upon the solar/utility interface.

7. Research is required on the manner in which solar system owners perceive potential public policies affecting the solar/utility interface.

TABLE IV-I

IMPLICATIONS OF SOLAR OWNERSHIP ALTERNATIVES

Ownership Alternative	Potential Negative Implications	Potential Positive Implications
1. Regulated, monopolistic ownership of solar by utilities.	1. Lack of economic justification for monopoly. 2. Problems associated with regulation (internal subsidization, revenue constraint, etc.)	1. Optimized solar design for utility load mgmt. 2. High quality of system and service.
2. Regulated, but competitive ownership of solar by utilities.	1. Problems associated with regulation. 2. Quality standards might eliminate need for further economic regulation.	1. Same as above 2. Advantages of competition.
3. Unregulated competitive ownership of solar by utilities.	1. Possible internal subsidization.	1. Same as above 2. Utility input could prevent problems of nonoptimized design and product quality.
4. Competitive solar industry--no utility ownership.	1. Problems associated with competition (product quality, etc.) 2. Possibility of nonoptimized solar design to utility consideration. 3. Regulation may develop due to problems associated with competition.	1. Problems associated with regulation could be avoided.

IV. Legal and Regulatory Issues

POLICY OPTIONS

V.A. Solar Access ("Sunrights") and Land Use

1. It is suggested that no federal "sunrights" legislation preempting state efforts in this area be initiated at this time.

2. The following actions may be feasible for all states with technical assistance from the Federal government:

   2.a. Require that new developments include provisions for sunrights through restrictive covenants, height restrictions, or other traditional land use controls.

   2.b. Determine through the use of aerial photography whether shading is likely to be a problem.

   2.c. Confirm the right of individual property owners to negotiage easements to sunlight.

   2.d. Add solar energy impacts to the list of factors to be considered in comprehensive plans and applications for building permits.

   2.e. Adopt a legislative declaration that solar energy utilization serves a strong public purpose, as a benefit to the solar user in any litigation.

   2.f. Guarantee, in residential neighborhoods where significant changes in land use are unlikely in the near future, the right to sun of a rooftop collector over neighboring property.

   2.g. Experiment with additional innovative solutions to the access problem, such as solar overlay zoning, planned unit developments, and transferable development rights.

   2.h. Draft illustrative guidelines for localities to adopt clarifying the status of any aesthetic regulations that might apply to SHAC systems.

3. The federal government can aid the states by acting as an information base and clearinghouse (coordinating with NCSL, ALI and ABA) for state legislation enacted in this area and by drafting and disseminating model statutes and agreements, such as "express solar easement" agreements.

4. A more agressive, but still indirect, federal role which might be undertaken is the restriction of certain types of federal aid to states which have not taken action in the areas identified in 2.

V.B. Antitrust

5. Existing antitrust laws will apply to the SHAC market; however, new government action could make it less likely that anticompetitive practices will arise. Consideration should be given to encouraging federal agencies to assist small firms in utilizing Section 14 of the Solar Heating and Cooling Demonstration Act by developing an aggressive outreach program to encourage small businesses to participate in federal solar programs;

6. New legislative initiatives which may encourage similar results include:

   6.a. Enactment of a requirement that all Federal solar energy contracts above a certain dollar value awarded to companies be reviewed by the Justice Department and/or the Federal Trade Commission.

   6.b. Enactment of a law prohibiting any company with an interest in petroleum refining or production or in natural gas production from holding or acquiring any interest in the solar energy business.

7. With respect to antitrust implications of utility involvement in solar energy, no action other than enforcement of existing laws is necessary at the federal or state level. The one exception is that new antitrust laws may be needed to prevent attempts to monopolize through the use of advertising.

V.C. Property Tax Law

8. In states which have not already enacted legislation exempting solar equipment from property taxes, the federal government could encourage adoption of the model American Bar Foundation statue exempting SHAC systems from incremental property taxes. States which have already passed such legislation should be encouraged to review it to remove any ambiguities.

9. Consideration can be given to a federal grant-in-aid program to encourage such state legislation.

V.D. Morgage Law and Life Cycle Costing

10. The $55,000 loan "basket" of federally charted savings and loan companies could be reassessed and an exemption provided to accomodate financing of solar buildings.

11. The feasibility of legislation requiring lending institutions to move toward life-cycle costing decision criteria can be examined.

12. The federal government could require life-cycle costing for federal buildings and encourage state governments to do so for state buildings.

13. The feasibility of "open ended" and "wrap around" mortgages for financing solar retrofits can be studied.

V.E. Labor Law

14. It is recommended that no specific federal actions in this area be initiated at this time. Federal encouragement should be given to support of early jurisdictional negotiations amongs affected unions and to support of voluntary union cooperation.

V.F. Mobile Homes

15. HUD mobile home standards could be revised to facilitate future retrofit of SHAC systems by including structural support requirements adequate to support rooftop collectors and related plumbing provisions, where economically feasible.

16. The federal government can encourage states to:

    16.a. examine their lending laws to provide that loans to equip mobile homes with SHAC systems are available on the same terms as those for conventional housing;

    16.b. ensure that property tax ememptions granted to solar equipment on conventional buildings are also granted to solar equipment installed on mobile homes;

    16.c. Investigate the feasibility of increasing minimum mobile home lot sizes to accomodate ground-type solar collectors;

V.G. Mandatory Installation

17. Carefully drawn mandatory installation laws may survive court challenge; however, federal action of this nature is not advisable. Consideration at the state level should be given to the feasability of measures to provide that buildings are constructed so as to allow retrofit at a later date.

DISCUSSION

V.A. Solar Access ("Sunrights") and Land Use

Land use controls have developed in sophistication and diversified in technique in the past twenty years. The extent of regulations exerted by land use controlling agencies has generally increased during this period, although the level and type of regulation vary greatly from jurisdiction to jurisdiction. This development has progressed without substantial regard to solar access or to the utilization of SHAC systems. Integrating the proper considerations of solar access and technology into land use planning is important to ensure that land use controls do not create structures and constraints which unduly restrict the availability and feasibility of solar energy.

Land use controls have historically beeen the primary province of local and state governments, and will probably remain so. These jurisdictions are closest to the concrete problems faced by land planning strategies. Further, the diversity of land use planning approaches and techniques discourages a uniform national approach. Local and state governments should be encouraged to become aware of the needs of solar access and solar technology, to develop explicit public policy to facilitate the development of solar energy, and to investigate existing land use controls to remove barriers to solar application which may currently exist. Certain planning approaches, such as planned unit development, should receive priority attention.

A person's "right to light" is an object of concern among solar advocates. Research is continuing to ascertain whether this is a real problem of magnitude requiring across-the-board legislative action. ERDA and HUD are co-sponsoring a workshop in 1977 to assess the legal aspects of this problem. In the interim,

legislative steps can be taken by the states to recognize the right of individuals to contract among themselves for solar access easements.

Land use planning and controls are receiving much attention currently as areas of governmental regulation that can address environmental issues, energy conservation concerns, and problems of urban growth and sprawl. HUD is funding a study of land use planning as a means of assuring access to sunlight.

Antitrust

There are two potential problem areas related to antitrust; the organization of the new SHAC market and the relationship of public utilities and utility regulation to SHAC. With respect to the former problem area, two major concerns have been expressed by analysts of the problem. The first is that large energy corporations will use their power in other energy markets and their influence in the energy consulting business to retard the development of solar energy. The second is that large corporations will enter the solar energy market and restrain competition through anticompetitive marketing arrangements, monopoly pricing and restrictive production policies. Tied to both of these is the fear that small businesses may not be able to participate effectively in the solar energy industry. One danger presented by a large business monopoly of solar research is that those businesses may develop facilities and expertise which can present a future "barrier to entry" into the solar energy market.

There is nothing which distinguishes the SHAC market as far as the applicability of existing antitrust laws is concerned; however, there is room for the government to take preventive measures. Federal agencies could be encouraged to take administrative steps to strengthen their compliance with Section 14 of the Solar Heating and Cooling Action of 1974. In

addition, steps can be taken to encourage small business participation in the solar energy market.

Existing utilities may feel threatened by moves toward the widespread installation of SHAC equipment. This raises the possibility that the utilities may either seek to restrain the development of solar heating and cooling or capitalize on it by using their existing monopoly power to gain control of the new solar industry. At the federal level these possible anticompetitive issues are similar to those issues which the existing broadly worded antitrust provisions are commonly employed to punish and deter. At the state level, 43 states have antitrust offices, and the recent trend is to increase antitrust activities.

Little or no action short of enforcement of existing laws is necessary at the state or federal level with regard to preventing antitrust abuses by existing utilities. The possible exception is the prevention of an attempt to monopolize through the use of advertising. One way to eliminate the use of advertising as a barrier to solar implementation is enactment of bills prohibiting utilities from including advertising costs as an operating expense recoverable through consumer rates.

V.C. Property Tax Law

Solar equipment will add to a structure's assessed value, but to include this addition in assessments may tend to discourage the utilization of SHAC systems. Property taxes are collected in all states, with practically all the revenue obtained remaining at the county or municipal level at which they are levied. There are many actions state governments can take to influence these taxes, including defining what is and is not taxable. On the other hand, there has historically been resistance to federal government involvement with local property taxes. Unless basic constitutional rights are

involved, it is unlikely that the near future will see much federal involvement with property taxes, and direct federal involvement is not advisable.

It can be argued that a solar energy system puts no additional burdens on a community, and exempting solar equipment from property taxes would encourage building owners to select the solar option. The American Bar Foundation (ABF) has drafted a model statute that would have states exempt solar energy systems from property taxes. The federal government could encourage all states to adopt this model ABF statute.

There may be legal problems in exempting solar equipment from property tax assessments, as most states have "uniformity clauses" in their tax laws and/or constitutions. In some states constitutional changes may be required, and it is likely that test cases will soon be in the courts. As of January, 1977, 17 states had enacted solar property tax exemptions and similar bills were pending in other states. However, most existing and proposed legislation has some important flaws. Laws that protect solar systems from high assessments must take clear positions on how backup systems are to be assessed, the definition of "solar energy systems," the treatment of solar easements in assessments, and related issues. In states where such legislation has been enacted or is pending, the legislation should be reviewed to ensure that ambiguities relating to these points are resolved. The role of the federal government is this area should be limited to emphasizing the significance of such legislation and to, perhaps, the initiation of a grant-in-aid program to encourage states to adopt this legislation.

V.D. Morgage Law and Life Cycle Costing

Federally chartered savings and loan companies are regulated by an act which states that an institution making a loan of over $55,000 must put the entire amount of the loan into a "basket" that can never hold more than

20% of the corporation's assets. Since commercial loans are included in this basket, this severely limits the size of home loans available. The effect of this restriction on solar homes, whose cost is substantially higher than that of conventional homes, is detrimental. This restriction could be modified in one of three ways: the law could be amended to raise the $55,000 limit, it could be amended to state that only dollars in excess of $55,000 must go into the basket, or it could make exceptions for solar and energy conserving buildings.

Most lenders use borrowing underwriting criteria that exclude utility and fuel costs in assessing an applicant's ability to pay--they usually use the standard PITI (principal, interest, taxes, insurance) formula. The feasibility of legislation that would require lending institutions to make loans on this basis should be closely examined.

On the federal level, the Federal Supply Service of the GSA has awarded some contracts on a life cycle costing basis. This approach could be encouraged and expanded. Several states now require life-cycle costing for government buildings, and others are considering bills to require life cycle costing to be used in considering bids for government purchases. All states could be encouraged to make similar changes in their laws controlling government procurement.

Retrofit solar installations face higher interest rates and shorter terms--both of which impact unfavorably on the economics of SHAC systems. Options for reducing the interest rate and lengthening the time period for solar retrofit loans should be explored. One possibility is an "open-ended" mortgage clause that allows a building owner who has built up equity to borrow back up to the amount of the original loan at the original terms. Another possibility is the "wrap-around mortgage" in which a

new loan is "wrapped around" an existing mortgage. The new mortgage is for an amount equal to the outstanding balance of the first mortgage plus any additional funds loaned; its interest is always equal to or lower than the current market rate on similar properties. Still another possibility is state legislation, already enacted in Massachusetts, permitting the financing of second mortgages for energy conservation equipment and SHAC systems at favorable rates.

V.E. Labor Law

Labor law issues related to SHAC could arise in several different ways: union uncertainty concerning a new technology, jurisdictional disputes, or through conflict over work assignments. The issue of greatest concern is likely to be determining which union has jurisdiction over a particular job. Thus far, labor jurisdictional problems have not been a serious constraint to SHAC. On the other hand, labor unions are unlikely to dispute control of a new product until there is a definite market involved, and that stage has not yet been reached with solar energy.

If a strike results, federal arbitration procedures are preemptory. The National Labor Relations Board has authority to settle the strike unless the parties reach a voluntary agreement. States could legislate procedures to settle differences prior to a strike, assuming that a right to strike exists under federal law. No constitutional barriers preclude further federal regulations in this area and creation of a Solar Energy Labor Board to recommend appropriate regulations has been suggested. However, little proof exists that such an organization is necessary, and no specific federal action in this area is recommended. At present, it is felt advisable to encourage voluntary union cooperation.

V.G. Mobile Homes

In recent years mobile homes have accounted for between 25 and 30 percent of all new housing starts. However, one of the major problems in establishing a secure market for solar-equipped mobile homes is the nature of the market. Mobile homes are relatively inexpensive and are often owned by sectors of the population not enthusiastic about life-cycle costing. Since SHAC may not be economically feasible until sometime in the future, the opportunity must be maintained to increase the future market through retrofit. Construction standards for mobile homes are established nationally in the Mobile Home Construction and Safety Standards promulgated by HUD. These HUD mobile home standards could be revised to include structural support requirements adequate to support rooftop collectors for those mobile homes where SHAC systems may be economically feasible.

Financing of mobile homes represents a serious constraint, for interest rates are higher and the duration shorter for mobile home mortgages than for conventional home mortgages. Assuming the cost of the SHAC system is included in the mortgage, this will have serious implications for the economic competitiveness of a solar equipped mobile home. The federal government can encourage states to modify their lending laws to provide that loans to equip mobile homes with SHAC equipment are available on the same terms as those for conventional housing.

Another barrier to the use of solar energy in mobile homes is tax policy. In many areas mobile homes are treated as personal property and, as such, are not eligible for the solar property tax exemptions being considered in the state legislatures. Mobile homes could be taxed as real property or state laws exempting solar equipment from property taxes could be amended to include personal property tax exemptions for mobile home

owners, where applicable.

About one-half of all mobile homes are located in mobile home parks with only minimal size lots. States can consider the feasibility of increasing minimum lot sizes to accomodate group type solar collectors and consider making land available in mobile home parks for collective solar systems.

V.G. Mandatory Installation

A principle question governing the legality of mandatory solar installation requirements is whether they constitute a "taking without compensation" in violation of the Fifth Amendment of the U.S. Constitution. Although this question is difficult to answer with any certainty, there are precedents upholding requirements for building design and construction methods. The federal government may become involved in mandatory installation requirements. through the HUD Minimum Property Standards. While carefully drawn mandatory installation requirements may survive court challenge, at the present time it is premature to recommend such a measure. An approach to follow in the interim is for the states to explore measures which have been suggested (and adopted in Florida) to provide that buildings be constructed so as to allow retrofit of SHAC systems at a later date.

RESEARCH RECOMMENDATIONS

1. Comprehensively investigate the "sunrights" issue and analyze model legislation.

2. Prepare a rigorous definition of the term "solar" for use in legislation.

3. Review the approval processes for land developments (including planned unit development, cluster zoning, floating zoning, and other such techniques) to identify ways in which consideration of solar access and technology problems may be best incorporated into them.

4. Evaluate the legal consequences, particularly anti-competitive effects, of the various proposals for utility involvement in the SHAC market.

5. Review the legality of the various utility rate structure proposals which encourage SHAC utilization.

6. Analyze state Public Utility Commission jurisdiction over solar users.

V ERDA PATENT POLICY

POLICY OPTIONS

1. ERDA does not have a separate patent policy for its solar heating and cooling program, and development of such a policy is not advisable, because the principles which should guide patent policy are generic to the entire federal energy R&D effort.

2. Consideration should be given to the modifications in ERDA patent policy listed below to facilitate R&D in the solar heating and cooling program and in other areas as well:

   2.A (1) Dissemination by ERDA of a clear statement that it stands ready to listen to and to attempt to accomodate contractors who have need for more enforceable rights in their work than are provided in ERDA's standard non-exclusive license clauses.
   (2) Distribution of clear guidelines to the patent counsels working in the regional offices and actually passing on contract clauses so that there is no discontinuity between ERDA's public pronouncements and the understanding of ERDA's regional personnel.
   (3) Amendment of the Patent Policy Regulations to reflect ERDA policy as clearly as possible so that regional personnel will feel free to grant greater than minimum rights when it accords with the currently tacit policy behind the regulations to do so.

   2.B (1) Development by ERDA of devices, such as an informal patent counseling procedure or a telephone patent advice service, to help uninitiated potential contractors understand the admittedly complicated patent policies.
   (2) Development by ERDA of a procedure so that early in the stages of negotiation of patent and data clauses of contracts any questions over policy can be settled without contradicting the regional patent counsel.

   2.C Establishment by ERDA of a two-tiered patent policy in which the standard arrangement with large contractors remains the grant of a non-exclusive license, and the standard arrangement with small contractors becomes the grant of an exclusive license. The regulations can be revised to reflect this change in policy clearly. Medium-size contractors could possibly be given some kind of intermediate position, such as a short-term exclusive license to supplement the non-exclusive license.

2.D Clear definition in contracts of the various options which ERDA might exercise with respect to allocations of rights to subsequent inventions, and the criteria under which those options will be exercised.

2.E Recognition, in the granting of limited term exclusive licenses by ERDA, that small businesses may require more time to develop inventions and should be granted longer terms accordingly.

2.F Clear definition of ERDA's background patent rights policy. Firms with usable background patents should be able to license them freely to third parties, thus enhancing the dissemination of technologies.

DISCUSSION

1. ERDA Solar Energy Patent Policy

ERDA's patent policy is basically sound, and substantial changes are not necessary. The expression of that policy, however, could be improved. Considerable revision of the regulations may be needed to make the policy explicit and specific, to ensure that potential contractors are aware of the policies and their applications and that the officials in the regional offices are aware of the policies and their applications, and to recognize the operative differences between small and large firms with respect to some patent rights and procedures.

2. Modification in ERDA Patent Policy

Small firms and others not accustomed to government contracting may be discouraged from responding to RFP's or participating in contracting because of the complexity of the ERDA patent regulations. ERDA headquarters' internal policy of cooperation with contractors with special problems is not widely known either among potential contractors or in some of ERDA's regional offices. Accordingly, policy options 2.A and 2.B are proposed to increase awareness of ERDA's policy and to provide ways for individuals to obtain patent policy information from ERDA as well as for regional patent officers to

obtain early and clear advice on what they should be willing to grant in the way of greater than the usual limited rights in patents. The latter point has been made by both contractors and ERDA officials within the Division of Solar Energy. It is particularly important that regional personnel know what headquarters' policy is, since contractors may be reluctant to appeal over the local official's head. Such an appeal can result in a favorable outcome in the particular case, but great difficulties in dealing with the local official later. This can have a chilling effect on contractors and may cause some to walk away from a particular contract rather than jeopardize their chances for contract work in the long term.

The policy of granting nonexclusive licenses and limited-term exclusive licenses impacts small firms more negatively than large ones. The latter often do not need the protection of exclusive licenses while they are in the process of developing a product, and are not deterred by short-term exclusive rights. In order to ensure the opportunity for realistic and adequate participation of small business in the ERDA/SOLAR R,D&D effort, policy options 2.C and 2.E are proposed. These are premised not so much on the belief that small businesses should be given preferential treatment, as on recognition of ERDA's Congressional mandate for small business participation and consideration of small business status in granting waivers (42 U.S.C. sections 5512 and 5908 (j)). It must also be recognized that small businesses have different needs in this area, which must be satisfied if they are going to participate adequately as members of the R&D community.

The lack of specificity with respect to options ERDA might exercise under particular contracts (especially concerning its rights to terminate a license for nonperformance or anti-competitive effects) and with respect to acquiring patent rights in patents made under the contract may deter firms from participating in contract work. Some flexibility in patent policy is a positive goal in the negotiation stage, but that goal should be modified to accomodate the contractor's need for specificity once a particular contractual arrangement is determined. Otherwise, the sweeping authority ERDA retains in the areas of background patents* and exercisable options, to be implemented without explicit guidelines, may create enough uncertainty to discourage participation. Vague criteria about background patent rights may further deter contractors who have already worked in the field and developed strong patent positions from contracting with ERDA. These may be just the people the ERDA/SOLAR R, D&D effort needs. Policy options 2.D and 2.F are addressed to these problems.

*Background patents are patents required to work the invention developed under the contract, and exist primarily in the situation where that invention builds on and improves some other process or technology already patented. To ensure that it has enough patent rights so that it can promote its R, D&D program, ERDA requires contractors to grant ERDA rights to the background patents as needed.

VI. Building Codes, Standards, and Warranties

POLICY OPTIONS

1. There is a need for nationally recognized standards for SHAC equipment and nationally recognized testing and listing organizations to certify compliance with those standards. These are long-term goals of the SHAC demonstration program.

2. Since definitive standards and certification organizations are not presently available, various interim steps can be taken:

   2.A. The current evolving standards of the federal government, developed for the demonstration program and federal procurement, can be adopted in building codes by states and localities.

   (1) This could be forced by mandatory federal legislation.
   (2) It could be encouraged by federal incentives programs.
   (3) It could be left up to the states to adopt the standards on their own.

   2.B. If the evolving federal standards are to be adopted, there would still remain the question of who should certify compliance of particular systems and components with the standards.

   (1) This could be done by the federal government.
   (2) It could be left up to the states or some private organization.

   2.C. There is a similar need for nationally recognized performance-based standards for SHAC equipment to form the basis for warranties and to increase consumer confidence. These are also goals of the SHAC demonstration program.

3. Other minor barriers in building codes, not related to standards, could be studied, and an effort could be made through the model building codes organizations to develop, with federal support, model legislation to remove these barriers.

4. In the interim, federal legislation could require mandatory warranties or provide federally underwritten comprehensive service contracts.

   4.A. Currently, knowledge of SHAC system durability and reliability is insufficient to form the basis for mandatory warranties. When further data have been collected in the demonstration program, this approach can be considered.

   4.B. Similarly, due to lack of data, comprehensive service contracts would not appear to be advisable at present. They may later become feasible, and they could be considered at that time.

DISCUSSION

1. Need for National Standards

The typical building code has nationally recognized standards for conventional heating and cooling equipment, but it has no standards for SHAC equipment. For this reason, SHAC equipment is vulnerable to the broad discretionary powers of building officials. They may require that new materials and systems be tested and proved to be at least the equivalent of the usual materials and systems in quality, strength, effectiveness, fire resistance, durability, and safety. Because of the wide discretion in this matter, local requirements could vary greatly with time and place. If strictly applied, these differing local requirements could make SHAC systems less competitive due to the uncertainty, delay, and expense in processing permit applications. They could easily fragment a potential national market into hundreds or thousands of small markets, or result in unnecessarily expensive products designed to meet the strictest standards found anywhere.

The three most widely used model building codes are those written by the Building Officials and Code Administrators, International; the International Conference of Building Officials; and the Southern Building Codes Conference. Well over half of the cities with building codes have adopted one of these three codes. These codes are thus representative of building codes generally, and the remarks about requirements for new materials and systems applies to them as well as to the thousands of local codes based on or similar to them.

The best long-term solution to this problem would be nationally recognized standards and testing procedures for SHAC systems and nationally

recognized procedures to certify compliance with these standards and grant listings. These standards should be adopted by reference in all local and state building codes, and listings should be accepted as sufficient proof for code-approval if the equipment is installed in compliance with the conditions given in the listing. This would merely put SHAC systems on the same footing as gas and electric systems.

Before consumers invest heavily in a SHAC system, they need information to determine the risk and ascertain that the risk is manageable. Nationally recongized performance-based standards and certification, analogous to AGA- or UL-approval, are important tools to provide this information. Such standards would allow for further development of the new technology, give flexibility to the builder or designer who uses the new technology, and give consumers a clear idea of what to expect from SHAC equipment. In the long term, performance-based standards can provide the necessary underpinning for comprehensive warranties.

NBS is current developing "definitive performance criteria" to be completed by 1977 and has already issued interim performance standards for federal procurement and demonstration projects. The government's demostration projects can be used to help develop the definitive standards of performance, to inform consumers of what can reasonably be expected from SHAC equipment, and to build consumer confidence in SHAC systems.

2. Interim Measures

The actions discussed above are planned as an integral part of the ERDA/HUD Solar Heating and Cooling Demonstration Program. In the interim other actions may be necessary. One policy that is feasible in the short run is the adoption of the evolving federal standards and test procedures

for SHAC systems, components, and materials. Adoption could be done either by federal legislation making the federal standards mandatory nationwide; by federal legislation making adoption of the federal standards by states voluntary, but with incentives to make state adoption likely; or by leaving it to the states to adopt the federal standards on their own, as a few already have.

The advantage of the first of these options is that it would quickly result in uniform nationwide standards. Although definitive standards for SHAC systems have not been developed, the interim standards for residential and commercial SHAC systems, the intermediate minimum property standards for solar heating and domestic hot water systems, and test procedures developed by the NBS are clearly the best currently available. The federal enactment of such building standards, although it has not been done before, might be sustained by the courts as within Congress' extensive commerce and defense powers. Opposition to such precedent-setting legislation (even in so limited a field as SHAC standards) might be overwhelming. Nonetheless, the feasibility and desirability of doing this alternative is worthy of serious study.

The alternative of leaving the states the power to decide whether to adopt the federal standards, either with or without incentives to do so, would probably encounter less opposition. This alternative may not, however, yield the desirable national uniformity that could help most in achieving widespread use of SHAC systems. In view of the still developing nature of the current standards, the most reasonable approach may be to provide states information on the federal standards, pending development of definitive standards with incentives to make state adoption as broad as possible. This would allow states to adapt the standards to local conditions.

An issue of great importance is who should be responsible for certifying system and component compliance with the standards. Early experience with federal certification of systems for the HUD demonstration program proved unsatisfactory, and this may lead to opposition to any federal certification program. The certification program could be made self-supporting through fees, but certification should be available to all. Certification should be frequently reviewed (especially when standards are changed). The federal government, however, has generally not wished to judge the relative merits of one commercial product versus another, which certification inevitably involves. Thus, the possibility of state or private testing and certification should be explored as an alternative.

3. Other Barriers and Incentives in Building Codes

Building codes also contain other barriers to SHAC systems. Various provisions, for example, limit the overhang of roofs (which precludes some passive designs), require windows of certain sizes on all sides of buildings (causing loss of heat through northern windows), and require more ventilation than is really needed for health and comfort (raising the output requirements from heating and cooling systems). Even before development of the standards and certification procedures for SHAC systems, the federal government could support a cooperative effort by the model building code organizations to identify and revise provisions that would discourage SHAC systems. Since this effort may involve some duplication of effort with standard adoption, it may be more desirable to undertake both projects simultaneously.

Building codes could also be used to provide incentives for SHAC systems, or even mandatory installation requirements under certain circumstances.

But with the possible exception of stricter standards for energy conservation in buildings (such as ASHRAE 90-75), there appears to be no reason to provide incentives in building codes once the barriers are removed. Such incentives are better left to subsidies, loans, loan guarantees, property tax exemptions, income tax deductions or credits, or other incentive mechanisms.

4. Mandatory Warranties and Comprehensive Service Contracts

Mechanisms that would help overcome consumer uncertainty about the reliability of SHAC systems are those that clearly allocate the burden of repair costs in advance: comprehensive warranties of performance or service contracts for maintenance and repair. These private mechanisms are now limited because SHAC manufacturers are caught in a circular problem. Until the manufacturers install enough SHAC systems to know what problems can be expected, it is too risky for them to offer broad warranties; meanwhile, consumers are duly cautious about buying systems without adequate performance warranties, retarding the collection of the very information on which warranties would be based.

Mandatory warranties may offer a potential solution to this problem, as they would greatly reduce consumer uncertainty while limiting the proliferation of substandard systems. However, we do not yet know enough about SHAC system reliability to require mandatory warranties on such systems. When sufficient data have been generated there may still be questions as to the desirability of mandatory warranties, for such a policy could constitute an extension of government influence into the relationship between buyer and seller. The advantages and disadvantages should be carefully examined in the context of different possible programs.

A similar problem exists with the development of comprehensive service contracts for maintenance and repair. The federal government could choose to underwrite service contracts, at least temporarily, so that they could be offered by private manufacturers. Such a policy would inspire public confidence in SHAC systems that would have far-reaching implications. It would also allow manufacturers to offer comprehensive service contracts without fear of financial ruin, and would provide consumers with a more certain knowledge of the risk that they assume in buying SHAC systems. On the other hand, such "backup insurance" could encourage adoption of substandard merchandise and could be quite costly to the government. Thus, government underwriting of service contracts is a highly questionable policy. If it is to be done at all, the government should require that systems demonstrate their compliance with the current federal standards for SHAC systems before being covered. This matter is also worthy of further study.

RESEARCH RECOMMENDATIONS

1. The federal government should study the feasibility and desirability of state and local adoption of the federal standards for SHAC equipment in their building codes. Alternatives considered should include mandatory federal requirements as well as federal programs encouraging state adoption.

2. The federal government should study the feasibility and desirability of federal versus state or private certification of SHAC system compliance with standards.

3. The federal government should study the feasibility and desirability of mandatory federal requirements for SHAC system warranties and of federally underwritten comprehensive service contracts.

4. The federal government should support an effort by the model building model codes organizations to develop model legislation that would remove those barriers from building codes that are not related to standards.

VII. MARKETING, MANPOWER, CONSUMER AND ENVIRONMENTAL ISSUES

POLICY OPTIONS

A. The Technology Delivery System (TDS)

1. A detailed analysis of the structure and nature of the solar energy production and marketing system can be initiated.

2. The federal solar incentive program can be designed to complement, rather than substitute for, the incentives and marketing strategies employed by the private delivery system.

B. Manpower Issues

1. A complete examination of the manpower requirements of the solar energy industry could be undertaken.

2. Teacher training capability, curricula, and pilot educational programs relating to solar energy skills can be developed.

C. Consumer Information and Attitudes

1. A major public education program could be initiated to emphasize the realistic potential of solar energy in the near future.

D. Environmental Issues

1. SHAC systems could be employed in cities where industrial expansion may be limited by proposed EPA environmental regulations.

DISCUSSION

A. The Technology Delivery System (TDS)

The concept of a Technology Delivery System (TDS) was suggested by the National Academy of Engineering in 1973. The TDS is composed of the many types of public and private institutions, agencies and individuals that interact to achieve the production and distribution of a product or service, in this case, SHAC equipment.

Regional differences in demand, as well as resources and capability, may increase the complexity of the problem. This heightens the need for an effective program to learn of needs and resources, as well as to bring about the required interactions and performance of the various components of the TDS.

A-1. Analysis of the TDS

An analysis is required that includes alternative systems and resources by region to develop the delivery system described above. The product of such an analysis will include: a description of the several elements of the TDS; a listing of the products that can be produced; the cost of such products; a statement of the economic, financial, manpower, social and other forces, including interactive processes, affecting the efficiency of the system. The analysis must assess the impact of involvement in solar energy on the several elements of the TDS. The analysis should consider such issues as the resistance of such agencies as financial instititions toward funding of construction projects using solar equipment. Uncertainty about resale value of buildings, durability of equipment, life cycle cost data, relationship to money market changes, etc., should be included.

Sponsorship of local or regional meetings of members of the TDS, to learn more about their resistance and to familiarize them with the use of solar energy in their specific area, would be constructive. These may be homogeneous meetings of bankers and financial institutions or of builders. Or they may be heterogeneous meetings of the interacting members of the technology delivery system to determine where system discontinuities exist, or where expectations are not shared. This is an area where the question of the appropriate Federal role must be carefully addressed.

There are three types of organizations in the SHAC TDS, those having to do with:

1) the production of solar equipment
2) the maintenance of solar equipment
3) the interface segment, that is builders, architects, vendors financiers, government regulatory agencies, etc.

The planned development of a new industry, or even the facilitation of its development, is a complex process. As a fledgling producer and distributor, it faces competition from better capitalized and subsidized institutions. It may lack credibility and acceptance, and a smooth interaction and mutual familiarity of the independent elements within the industry may not exist. In addition, there are both personal and institutional fears and barriers that may assume the role of "self-fulfilling prophecies". There is uncertainty about innovation. Financial institutions are perpetually beset with fear of the unfamiliar, market and manpower problems and building code variations, as are real estate agencies or builders with problems of consumer acceptance and resale.

Each individual role in the TDS has its unique point of view, concern and opportunities. They may not fit together effectively, and can lower the efficiency and even the viability and competitiveness of the industry as a whole. This is further complicated by the potential ambivalence of some TDS members who may be marketing competing energy delivery systems. It may, therefore, be necessary through the use of incentives, codes and standards, consultation and other unifying measures to attempt to achieve a technology delivery system, motivated by competition, to produce a sound product in a profitable and constructive industry.

Finally, sound and well based assessments of the future of the solar industry should be prepared for distribution to the members of the TDS. This will provide greater perspective concerning direction, needs, options and problems that will probably be encountered. These may differ for different regions of the nation and for different emerging economic sectors. The increased familiarization with the "geography" of solar energy should make it easier for a TDS member to operate effectively and economically.

A-2. Efficiency of TDS Activities

On the basis of the analysis of the technology delivery system and of the characteristics of each of the roles within the system, e.g., lender, builder, etc., specific incentives can be identified to motivate each level in the TDS system to work toward the increased utilization of solar energy in appropriate settings. These incentives may be tangible economic ones, or more subjective ones such as increased security, pride in work, etc.

The TDS has as much to gain from the incentive package as does the solar purchaser and the nation as a whole. Nothing would be more disastrous for the solar heating and cooling program or for the industry than to face charges of subsidizing the stockholders of the solar industry because of administrative oversight in the design of the program. Consequently, the incentive program should be designed to insure that it does not duplicate, and hence displace, what the TDS would have done anyway to hasten the adoption of SHAC. Therefore, a preliminary study must be made of the likely marketing strategies to be employed by the TDS before the final decision is made on the contents of the incentive package. The incentive package should include some provision to ensure that a subsidy

is not completely absorbed by the higher prices the TDS might charge as a result of the subsidy program.

B. MANPOWER ISSUES

B. 1. Manpower Assessment

A study of the manpower needs of the several elements of the SHAC industry should address the technological and economic impacts on manpower, as well as motivational and pedagogical aspects of the problem. Based on a sound demographic data base, it could indicate available labor sources that can be drawn from now-declining occupation areas without loss of income or status.

Associated with such a study would be recommendations for curricular changes ranging from high school and trade school, to university level courses that would contribute skills and manpower to the emerging solar, and other non-fossil, energy industries. The objective would be to assure emerging research, planning, construction and maintenance capability. The training programs should be characterized by:

1) the avoidance of a new jargon that bars newcomers
2) preparation for emerging areas of solar technology
3) use of continuing education programs, where possible, to foster on-the-job training.

Another aim of such a study should be to examine the existing manpower training and job-finding mechanisms in different states and regions, and to develop procedures for assuring that full information and exchange of data is available to this manpower and job channel, as the solar industry develops.

B-2. Training Programs

In conjunction with the Office of Education and the National Institute of Education, teacher training capability, solar training curricula and pilot educational operations could be encouraged in specific regions of the country to assure that necessary training resources are available. A task force of industry, labor, builders, architects, employment service personnel and educators could develop locally relevant patterns of training. Such a group would implement, on a pilot basis when development is mature enough, a balanced education, placement and information program.

C. CONSUMER INFORMATION AND ATTITUDES

C-1. A Major Public Information Program

The media, education, the SHAC demonstration program, person-to-person (word of mouth) communication, as well as other stimulative programs, could be employed to develop public awareness of the realistic capabilities of solar energy. Meetings with "gatekeepers", such as architects, builders, real estate salesmen, bankers and building owners and others involved in the procurement of solar equipment, will increase the awareness that SHAC systems are viable. Feedback from the public and industry concerning doubts and hesitations and changes in attitude, should be obtained and employed as a basis for planning public information.

Full information should be provided the public conerning the economic, financial and other incentives that can make solar energy available to the average building owner or consumer. Education concerning life cycle costing can be promoted via banks, schools, media, etc. Programs in collaboration with school systems, public and private broadcasting systems,

the news media, labor unions, environmental groups, business and industrial journals, etc., can be developed to disseminate information in a manner that will promote intelligent discussion of this energy option.

A document is needed that can present to the consumer the information required to make sound decisions about SHAC systems. Handbooks describing in clear language the advantages and disadvantages, the economics, life cycle costing and the mechanics of the equipment could be prepared to assure that facts prevail over mythology.

A considerable portion of the success of the solar energy program depends on state and local facilitation. State laws and regulations will require revision or recodification if any of the barriers to the use of solar equipment are to be eliminated. A variety of methods should be employed to inform state and local officials and legislators and to obtain feedback concerning their attitudes and preferences. These methods may include conferences, site visits, involvement on task forces, and a rapid response service available during periods when state legislators are drafting or considering new legislation.

D. Environmental Issues

Proposed new EPA regulations may limit industrial expansion in areas apporaching or exceeding pollution limits. The use of solar energy in these areas would permit industrial expansion without increasing pollution A proportion of all energy in such areas could be required to be solar, with necessary incentives and subsidies to minimize hardships.

Environmental considerations could have a negative effect on economic growth, productivity and employment levels. Solar energy provides a means for continuing or expanding the availability of energy in

pollution endangered areas without contributing to pollution. The demonstration of this benefit of solar energy should increase its attractiveness to industry and to municipal authorities. On the other hand, requiring the use of SHAC systems in situations where they are clearly uneconomic could retard economic growth and contribute to the inefficient use of limited capital through federal subsidies.

RESEARCH RECOMMENDATIONS

A. The Technology Delivery System

1. Study of the effects on the delivery system of the alternative structures or forms that the TDS may assume, e.g. vertical integration, horizontal integration, association with other energy industries, etc. Such criteria as efficiency, cost, pricing, market penetration, legal problems, etc., may be employed.

B. Manpower Issues

1. A study, in conjunction with the appropriate labor unions, to determine the likely impact of solar technologies on the skilled labor market, and on specific jobs.

2. A study, in conjunction with the National Academy of Science, of the implications of solar energy technologies on the job market for scientists and engineers.

C. Study of Public Attitudes

1. A continuing search program using a variety of data gathering methods to monitor changing attitudes toward solar energy throughout the country and to determine which are the best target groups.

2. A study of the spread of the effect of demonstration programs to determine the pattern of information transmission.

3. A program of basic research, addressing the potential of solar energy to the individual consumer. The program should assess fundamental benefits, fears, and uncertainties associated with solar energy.

D. Environmental Issues

1. A program to study the effect of the use of solar equipment on the level of air and water pollutants in urban areas. This should include analysis of the thermal pollution frequently produced by burning fuel.

2. An assessment of effects of the use of solar energy for water heating and for space heating and cooling on the daily activity of individuals living or working in such buildings. This would include changes in the diurnal cycle of individuals and groups which may be produced as a response to the availability of solar energy and to possible variable utility rates.

VIII. REGIONAL ASPECTS OF THE INCENTIVES PROGRAM

POLICY OPTIONS

1. Federal incentive programs could be made flexible enough to permit tailoring of the programs to fit the particular needs, characteristics, and natural incentives of the various regions of the United States.

2. The federal government could consider requiring that the states/regions share in the costs of the incentives program by adopting their own solar incentive packages as a precondition for their citizens' participation in the national subsidy program; such packages should reflect the local conditions found in a particular state or region.

3. Regional implementation centers can be established to aid in the proper design, execution, and evaluation of the incentives programs.

DISCUSSION

1. Flexible Federal Incentive Programs

An effective incentives program must take into account regional variation in the barriers to solar energy; otherwise, it will result in windfall gains for those in regions where barriers are low, and little impact where barriers are high. Thus, the nature and extent of an incentive program in the southwest -- a region characterized by summer peaking utilities, rapid growth, state laws already enacted to spur solar development, a healthy construction industry, active capital markets, high insolation, and high dependence upon natural gas -- requires a rather specific set of incentives in order to best deal with the set of problems facing solar energy in the region. Such an incentive program should differ substantially from one designed to overcome the northeast region's current barriers -- a region characterized by winter peaking utilities, dependence on oil and coal, comparatively slow economic growth, lower insolation, and relatively stagnant capital markets. The optimal mix of

incentives to apply in any particular region must be strongly dependent upon regional characteristics. It must be recognized that some barriers are best overcome by national strategies, some by state strategies, and some by local tailoring of the various incentive programs.

Certain incentives require uniformity across the nation for efficiency reasons, in order to hold down administrative costs, or to prevent inefficient "competition" between jurisdictions. However, one of the most important reasons for requiring that the incentive package have sufficient flexibility to permit tailoring to suit regional conditions, is that many barriers are specific to the jurisdictions themselves. Thus, there is little interest in model solar zoning codes in the Houston, Texas, area since Houston, like other southwestern cities, has no zoning ordinances. Other public barriers, such as restrictive PUC policies (Colorado is the prime example), building codes, land-use requirements, property taxes, and labor union jurisdiction problems differ widely in their degree of complexity and possible constraints upon solar energy development. For example, the solar/utility interface problem may be of less importance in New England, where more than 70 percent of the buildings are heated by oil, than in other regions. It is necessary to permit the incentives package to adjust to these particular local conditions.

A second major reason for regional flexibility is that some states and regions have already acted on their own to provide incentives to encourage solar energy, and it is important that the federal incentive package be designed so as to compliment, rather than substitute for, the

incentives already enacted. It is not equitable to penalize those states that have acted early on their own or to reward those states that have not. Thus, an optimal incentive package for New Mexico, which already has a state income tax rebate incentive enacted, would be substantially different than for a state such as Virginia where no incentive legislation for solar now exists.

Since the cost of conventional fuel and the degree of insolation differ widely by region, the size of the subsidy necessary to achieve a given market penetration is a strong function of the regional characteristics. The goal that incentive legislation should strive for is to ensure an equal marginal impact of the taxpayer's dollars upon market penetration and hence BTU savings in all of the areas.

It must be recognized that whatever incentive package is chosen the incentives must be compatible with the characteristics of the construction industry. Since this industry is highly regionalized in nature, this compatibility can best be achieved by a regionally oriented package. Sufficient precendent exists in other situations where new technologies were encouraged by regionally tailored programs.

Finally, unless the solar incentive package is designed with regional needs and capabilities in mind, the whole issue of the performance of the incentive program becomes far more complex. A program of incentives that is uniform throughout regions will, as a consequence, perform differently in different regions. Thus, a uniform national program must involve

regionally specific performance measures. If, on the other hand, the program were allowed to have a strong regional component, then the performance measures themselves could be made more uniform.

2. State Cost Sharing in the Incentives Program

The rationale for this option has three components: first, it is a way of achieving the regional variation desired with a minimum of administrative cost; second, it permits the introduction of the "equity principle" into the incentive program -- i.e., those regions that benefit the most must also pay the most; third, it will help ensure the interest, cooperation and support of the states in the effort.

No matter how much appeal a regionally oriented incentive program has in terms of maximizing the benefits of any program, it adds a degree of complexity and administrative cost that prohibits its universal application. Consequently, a way must be found to achieve regional variance without creating a bureaucracy that itself eats up all the incremental dollar and BTU savings generated by regionalizing the program. Such a mechanism exists: requiring the states to pass their own matching solar legislation to complement the federal incentives program, and to establish guidelines for the state efforts to enable the regional variance sought in the first recommendation. The administrative costs of such a decentralized plan could be minimized by utilizing the state energy bureaucracy now in place, which in many instances is seeking a new role in the energy policy area, with the declining interest in, and need for, state oil/gas allocation activities.

The principle of equity in treatment appeals to the common-sense notion of fairness in the government's dealings with its citizenry. One has to return only to the OPEC 1973 embargo to realize how regionally varied was its impact: while Los Angeles was passing ordinances designed to penalize electricity wastrels by fines, portions of the Southwest were completely unaffected by the shortage. Nor is this regional variance expected to diminish in the future. The gradual disappearance of natural gas as a source of BTU's (in order to conserve it for use as feedstock) will have a vastly differing regional impact. Hence, the conservation of BTU's by a strong solar incentive program will benefit some regions of the country more than others. This fact, when coupled with the "benefit principle," leads to the conclusion that the sharing of the cost of the incentive program by states in proportion to the benefits received by their residents is a highly appropriate organizing principle.

But the concept of a solely state funded solar subsidy program is even more "unjust" than that of a solely federally funded effort. One wonders if New Mexico taxpayers are criticizing their legislature for enacting the solar tax credit legislation on the grounds that while the state taxpayer pays the full cost of the program, the benefits, in terms of conventional BTU savings, accrue to the nation as a whole. Clearly, a comprehensive approach to a solar incentives program would include active participation by all levels of government.

A final powerful argument for designing a regionally cost shared incentives program is that it is likely to be effective. A study prepared recently for NBS identified the critical factors that determine the ability of a particular technology transfer program to achieve its goals, and it concluded:

> Analysis of the case studies indicates that projects successful in diffusion tend to have the following attributes: 1) a technology well in hand and 2) cost and risk sharing with local participants. Cases showing significant diffusion success involved non federal cost sharing. All of those funded entirely by the federal government resulted in little or no diffusion.*

Thus, a program that takes into account the needs of local participants, as one must when requiring non-federal cost-sharing, will very likely have far more impact than a centrally-dominated, centrally-controlled incentives program.

3. Regional Implementation Centers

The basis for the establishment of regional implementation centers stems from the fact that impediments to the adoption of new technologies in the construction industry are caused largely by frictional, non-economic factors, produced by the fragmented, regionally-based and tradition oriented nature of the industry. Therefore, even though SHAC systems may be close to being economically competitive, the short term prospects for commercialization by private market action alone appear to be small. It is unlikely that any sort of national incentive plan will succeed unless a specific program is developed that addresses the institutional impediments to technological change within the construction industry. Because of the complexity of the building process, a builder's perception that cost saving technologies could produce unacceptable risk tends to inhibit innovation in the industry.

One potential method for reducing the lag in adoption time would be to

* Analysis of Federally Funded Demonstration Projects, Volume 1: Executive Summary. RAND Corporation, Santa Monica, California, April 1976, p. iv.

establish several regional implementation centers which could not only communicate information regarding solar energy to the building industry in channels to which the industry normally responds, but also provide information regarding the complexity of the solar building application mix to the solar design community. Such implementation centers could be change agents and could encourage the widespread use of solar energy. They could be federally funded at a level consistent with national goals to reduce fossil fuel use and commensurate with the expected benefits of their operation.

The regional approach is justified largely by calling upon past failures of technology innovation programs that have not utilized the regional, user-oriented approach. The NASA Technology Utilization Program, which was initiated in 1962, did not really become an effective technology transfer program until the recent introduction of direct user/technologist interaction. On the other hand, the cooperative extension program funded by the USDA involved regional implementation and orientation. From the beginning the extension service thus provided a link between the farmer and the agricultural researcher, where the county agent provided the farmer with problem solving capability that was readily available to him. This user-oriented, regionally designed program was successful primarily because of this orientation and the solar incentives program should include within it such innovation centers in order to insure maximum market penetration. Specifically:

> (1) The location of an Implementation Certer should be most effective when located in close physical proximity to the community it wishes to impact. (2) In order for the staff of the Implementation Center to gain "credibility" and become a "trusted agent" of the target group they must not only have the technical knowledge and capability to assist in technical applications, but must also have skills in communication and good understanding of the environment in which the potential adopters operate. (3) The approach of an Implementation Center

> to the innovation process must be directed toward meeting the perceived needs or requirements of the target group. (4) Diffusion of the innovation is more rapid when incentives are available to encourage it. The greater the magnitude of the innovation, in terms of potential cost or process change and risk to the adopter, the more important incentives for adoption become. (5) If an Implementation Center is to have any chance to get off the ground, it must initially at least, provide its services free of charge. Thus early Implementation Center activities could be considered a trial of both the process and the specific innovation, where potential adopters could assess the applicability of the innovation to their situation.*

Such a Center could perform at least four functions. First, the Center could promote two-way communication between potential users and the solar energy community; this two-way information dissemination is necessary in order to provide up-to-date information on solar energy to the user and to communicate application problems back to the solar energy community. Second, the Center can provide an information dissemination function by providing pamphlets and technical briefs on solar energy. Third, the Center could provide an evaluative function, for one of the most important aspects of technology transfer is to have readily accessible and reliable evaluations of the early innovation uses and demonstrations. Lastly, the Center would provide a policy analysis function, which could result in design recommendations for possible incentives to encourage the use of these techniques. In order to achieve these objectives, the activities of the Center would be divided into three categories: first, education programs for the construction industry; second, information dissemination activities and, third, applied research programs that would concentrate on increasing the rate of diffusion of new products and services. In these Centers could be integrated the functions of the Solar Energy Research Institute (SERI) and the proposed Energy Extension Service.

*Alan S. Hirschberg, "Implementation Centers to Speed the Use of Solar Energy and Other Conserving Technologies," Report prepared for the National Science Foundation, 1976.

* U.S. GOVERNMENT PRINTING OFFICE : 1977 O-240-988/538